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JC600 U.S. PTO 10/29/99

JC525 U.S. PTO 09/430052 10/29/99

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventors: Matthew T. Crisfield; John Richard McCarthy

For (title): A CORIOLIS FLOWMETER HAVING A REDUCED FLAG DIMENSION FOR HANDLING LARGE MASS FLOWS

1. **Type of Application**

This transmittal is for an original (nonprovisional) application.

2. **Papers Enclosed**

A. Required for filing date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

9 Pages of Specification
3 Pages of Claims
3 Sheets of Drawings–Informal

B. Other Papers Enclosed

2 Pages of declaration and power of attorney
1 Page of abstract

CERTIFICATION UNDER 37 C.F.R. 1.10*
*(Express Mail label number is **mandatory**.)*
(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date 29 October 1999, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL388127364US, addressed to the: Box Patent Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

William P. Wilbar

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*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

3. **Declaration or Oath**

Enclosed

Executed by:

- inventors.

4. **Inventorship Statement**

The inventorship for all the claims in this application is the same.

5. **Language**

English

6. **Assignment**

An assignment of the invention to Micro Motion, Inc. is attached. A separate "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" is also attached.

7. **Fee Calculation (37 C.F.R. 1.16)**

Regular Application

CLAIMS AS FILED					
Claims	Number Filed	Basic Fee Allowance	Number Extra	Rate	Basic Fee 37 CFR 1.16(a) $760.00
Total Claims (37 CFR 1.16(c))	11	- 20 =	0 x	$18.00	$0.00
Independent Claims (37 CFR 1.16(b))	1	- 3 =	0 x	$78.00	$0.00
Multiple Dependent Claim(s), if any (37 CFR 1.16(d))			+	$260.00	$0.00
Filing Fee Calculation					$760.00

8. Fee Payment Being Made at This Time

Enclosed

Filing Fee	$760.00
Recording assignment ($40; 37 C.F.R. 1.21(h)) (See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".)	$40.00
Total Fees Enclosed	$800.00

9. Method of Payment of Fees

Check in the amount of $800.00 is attached.

10. Authorization to Charge Additional Fees

The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 04-1697.

37 C.F.R. 1.16(a), (f) or (g) (filing fees)

37 C.F.R. 1.16(b), (c) or (d) (presentation of extra claims)

37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

37 C.F.R. 1.17(a)(1)-(5) (extension fees pursuant to § 1.136(a))

37 C.F.R. 1.17 (application processing fees)

11. Instructions as to Overpayment

Credit Account No. 04-1697.

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A Coriolis Flowmeter Having A Reduced Flag Dimension For Handling Large Mass Flows

Field of the Invention

This invention relates to Coriolis flowmeters. More particularly, this invention relates reducing a flag dimension of a Coriolis flowmeter by using flow tubes having a substantially semicircular arc and one set of brace bars. Still more particularly, this invention relates to a configuration of components that maintains zero stability and reduces the amplitude of the vibrating flow tubes to reduce stress applied to the brace bars.

Problem

It is known to use Coriolis effect mass flowmeters to measure mass flow and other information of materials flowing through a pipeline as disclosed in U.S. Patent Nos. 4,491,025 issued to J.E. Smith, et al. of January 1, 1985 and Re. 31,450 to J.E. Smith of February 11, 1982. These flowmeters have one or more flow tubes of a curved configuration. Each flow tube configuration in a Coriolis mass flowmeter has a set of natural vibration modes, which may be of a simple bending torsional, or coupled type. Each flow tube is driven to oscillate at resonance in one of these natural modes. The natural vibration modes of the vibrating, material filled system are defined in part by the combined mass of the flow tubes and the material within the flow tubes. Material flows into the flowmeter from a connected pipeline on the inlet side of the flowmeter. The material is then directed through the flow tube or flow tubes and exits the flowmeter to a pipeline connected on the outlet side.

A driver applies a force to the flow tube in order to cause the flow tubes to oscillate in a desired mode of vibration. Typically, the desired mode of vibration is a first out of phase bending mode. When no material is flowing through the flowmeter, all points along a flow tube oscillate with an identical phase. As the material begins to flow, Coriolis accelerations cause each point along the flow tube to have a different phase with respect to other points along the flow tube. The phase on the inlet side of the flow tube lags the driver, while the phase on the outlet side leads the driver. Sensors are placed on the flow tube to produce sinusoidal signals representative of the motion of the flow tube. The phase difference between the two sensor signals is

proportional to the mass flow rate of the material flowing through the flow tube or flow tubes. Electronic components connected to the sensor then use the phase difference and frequencies of the signals to a determine mass flow rate and other properties of the material.

An advantage that Coriolis flowmeters have over other mass flow measurement devices is that flowmeters typically have less than 0.1% error in the calculated mass flow rates of a material. Other conventional types of mass flow measurement devices such as orifice, turbine, and vortex flowmeters, typically have 0.5% or greater errors in flow rate measurements. Although Coriolis mass flowmeters have greater accuracy than the other types of mass flow rate devices, the Coriolis flowmeters are also more expensive to produce. Users of flowmeters often choose the less expensive types of flowmeters preferring to save cost over accuracy. Therefore, makers of Coriolis flowmeters desire a Coriolis flowmeter that is less expensive to manufacture and determines mass flow rate with an accuracy that is within .5% of the actual mass flow rate in order to produce a product that is competitive with other mass flow rate measurement devices.

One reason that Coriolis meters are more expensive than other devices is the need for components that reduce the number of unwanted vibrations applied to the flow tubes. One such component is a manifold which affixes the flow tubes to a pipeline. In a dual tube Coriolis flowmeter, the manifold also splits the flow of material received from a pipeline into two separate flows and directs the flows into separate flow tubes. In order to reduce the vibrations caused by outside sources, such as a pump, that are connected to the pipeline, a manifold must have a stiffness that is sufficient enough to absorb the vibrations. Most conventional manifolds are made of cast metal in order to have a sufficient mass. Furthermore, there is a spacer between the manifolds that maintains the spacing between inlet and outlet manifolds. This spacer is also made out of a metal or other stiff material in order prevent outside forces from vibrating the flow tubes. The large amount of metal used to create these castings increases the cost of the flowmeter. However, the elimination of unwanted vibrations greatly increases the accuracy of the flowmeters.

A second problem for those skilled in the Coriolis flowmeter art is that

flowmeters may have a flag dimension that is too big to be used in certain applications. For purposes of this discussion, flag dimension is the length that a flow tube loop extends outward from a pipeline. There are environments where space is constrained or is at a premium. A flowmeter having a typical flag dimension will not fit in these confined areas.

It is a particular problem to reduce the flag dimension of flow tubes in a Coriolis flowmeters that handle large flow rates. For purposes of this discussion, large flow rates are 700 lbs./ minute or greater. One reason that reducing the flag dimension is a problem in flowmeter handling larger flow rates is that the flow tubes must have larger diameters. Larger diameter flow tubes have higher drive frequencies than smaller diameter flow tubes and are harder to design when reducing the flag dimension. The larger diameter of the flow tube also causes zero stability problems when a smaller flag dimension is created. For these reasons, it is a particular problem to create a dual flow tube Coriolis flowmeter capable of handling large flow rates.

Solution

The above and other problems are solved and an advance in the art is made by the provision of a Coriolis flowmeter having a reduced flag dimension in the present invention. The Coriolis flowmeter of the present invention has flow tubes that are capable of handling large mass flow rates. The Coriolis flowmeter of the present invention does not have a conventional manifold and spacer. Instead, the spacer is substantially surrounds the manifolds. This configuration reduces the cost of the flowmeter. The Coriolis flowmeter of the present invention also has a reduced flag dimension which allows the Coriolis flow meter of the present invention to be used in areas where space is at a premium and it would be impossible to use a conventional Coriolis flowmeter having a conventional flag dimension.

The flag dimension of the flow tube is reduced by forming the flow tubes in a substantially semicircular arc between inlet ends and outlet ends of the flow tubes. The semicircular arc reduces the rise of flow tube to reduce the flag height. In order to increase the accuracy of the flowmeter, the entire length of the semicircular arc must vibrate.

A driver is affixed to the flow tubes at a position along the semicircular arc of

each flow tube that is substantially perpendicular to a plane containing the inlet end JRM 10/29/99 and the outlet end of the flow tube. The driver is positioned at this point to ~~maximize~~ minimize MTC 10/29/99 the amount of energy applied to the flow tubes by the driver to cause the flow tubes to oscillate. Drive signals are applied to the driver to cause the drive to oscillate the flow tubes at a low amplitude to reduce the stress applied to brace bars affixed to the flow tubes. The driver must also drive the flow tubes to vibrate at a frequency that is higher than conventional flow tubes.

To separate vibrations modes in the flow tube while the flow tube is being oscillated, a first brace bar is affixed to the flow tubes proximate the inlet ends and a second brace bar is affixed to the flow tubes proximate the outlet ends. Brace bars are metal components that are affixed to each of the flow tubes at substantially the same location along the flow tubes.

In order to sense Coriolis effect in the oscillating flow tubes, the pick-off sensors have to be affixed to the flow tubes in a position that allows the sensors to detect the greatest amount of Coriolis force at a low amplitude vibration. This allows a lower amplitude vibration to be used in order to reduce the stress applied to the brace bar.

An inlet manifold and an outlet manifold may be affixed to the inlet and outlet ends of the flow tube to connect the flow tubes to a pipeline. Each manifold is a separate component that is cast separately to reduce the cost of material. Each manifold may have a flow path that bends substantially 90 degrees to connect the inlet and outlet ends of the semicircular arc to a pipeline.

A spacer is affixed to each of the manifolds to maintain the distance between the manifolds. The spacer is a structure having fours sides with opposing ends affixed to the inlet and outlet manifolds. The spacer encloses a hollow cavity. This reduces the amount of material used in casting ~~the both~~ delete JRM 10/29/99 MTC 10/29/99 the manifold ~~and spacer~~ delete JRM 10/29/99 MTC 10/29/99. Openings in the top side of the spacer allow the manifold to connect to the semicircular arc of the flow tubes which protrude outward from the spacer.

A casing may be affixed to the top side of the spacer to enclose the flow tubes. It is a problem that the casing may resonate a frequency that is close to the frequency of the vibrating flow tubes. This may cause inaccuracies in the readings of properties of material flowing through the flow tube. To change the resonant frequency of the

case, a mass may be affixed to the casing to change the resonant frequency of the case.

Description of the Drawings

The above and other features can be understood from detailed description below and the following drawings:

FIG.1 illustrating a Coriolis flowmeter having a reduced flag dimension;

FIG.2 illustrating a Coriolis flowmeter of this invention affixed to a spacer; and

FIG. 3 illustrating a Coriolis flowmeter affixed to a spacer and enclosed in a casing.

Detailed Description

Coriolis Flowmeter in General -FIG. 1

FIG. 1 illustrates a Coriolis flowmeter 5 comprising a flowmeter sensor 10 and meter electronics 20. Meter electronics 20 is connected to meter sensor 10 via leads 100 to provide density, mass flow rate, volume flow rate, totalized mass flow, temperature, and other information over path 26. It should be apparent to those skilled in the art that the present invention can be used by any type of Coriolis flowmeter 5 regardless of the number of drivers, the number of pick-off sensors, the operating mode of vibration. Furthermore, the present invention may be used in any system that vibrates the two flow tubes 103A-103B in order measure Coriolis effects as a material flows through the flow tube and then uses the Coriolis effect to measure a property of the material.

Flowmeter sensor 10 includes a pair of flanges 101 and 101'; manifolds 102-102'; flow tubes 103A and 103B; brace bars 120-121; driver 104; and pick-offs 105 and 105'. Flanges 101-101' are affixed to manifolds 102-102'. Manifolds 102-102' are affixed to opposing ends of flow tubes 103A-103B. Brace bars 120-121 are affixed to the flow tubes 103A -103B as described below. Driver 104 is affixed to flow tubes 103A-103B in position where the driver can vibrate flow tubes 103A-103B in opposition to one another. Pick-offs 105-105' are affixed to flow tubes 103A-103B at opposing ends to detect the phase difference in the vibrations at opposing ends of flow tubes 103A-103B.

Flanges 101 and 101' are affixed to manifolds 102-102' and connect flow tubes

103A and 103B to a pipeline (not shown). When flowmeter sensor 10 is inserted into a pipeline system (not shown) which carries the material being measured, material enters flowmeter sensor 10 through inlet flange 101 and the total amount of material is divided into two flows by inlet manifold 102 and is directed equally to enter flow tubes 103A and 103B. The material then flows through flow tubes 103A and 103B back into outlet manifold 102' which joins the separate flows. The material then flows through outlet flange 101' where it exits meter sensor 10. Manifolds 102 and 102' are made of a minimal amount of material.

Flow tubes 103A and 103B are selected and appropriately mounted to inlet manifold 102 and outlet manifold 102' so as to have substantially the same mass distribution, moments of inertia, and elastic modulus about bending axes W-W and W'-W' respectively. The flow tubes extend outwardly from the manifolds in an essentially parallel fashion.

Flow tubes 103A-B are driven by driver 104 in phase opposition about their respective bending axes W and W' and at what is termed the first out of phase bending mode of the flowmeter. Driver 104 may comprise one of many well known arrangements, such as a magnet mounted to flow tube 103A and an opposing coil mounted to flow tube 103B. An alternating current is passed through the opposing coil to cause both flow tubes 103A-B to oscillate. A suitable drive signal is applied by meter electronics 20, via lead 110 to driver 104. The description of FIG. 1 is provided merely as an example of the operation of a Coriolis flowmeter and is not intended to limit the teaching of the present invention.

Meter electronics 20 receives the right and left velocity signals appearing on leads 111 and 111', respectively. Meter electronics 20 also produces the drive signal on lead 110 which causes driver 104 to oscillate flow tubes 103A and 103B. The present invention as described herein, can produce multiple drive signals for multiple drivers. Meter electronics 20 process left and right velocity signals to compute mass flow rate. Path 26 provides an input and an output means that allows meter electronics 20 to interface with an operator. The internal components of meter electronics 20 are conventional. Therefore, a complete description of meter electronics 20 is omitted for brevity.

The configuration of Coriolis flowmeter sensor 10 allows flow tubes 103A-103B

to have a smaller flag dimension while maintaining the accuracy of the readings within .5% of the actual mass flow rate. Flag dimension is the length that a loop in a flow tube protrudes outward from a plane that is perpendicular to the loop and that contains the connected pipeline. A second advantage of the configuration of Coriolis flowmeter sensor 10 is that a less expensive manifold and spacer may be used.

In order to have reduced flag dimension, flow tubes 103A-103B have a substantially semicircular arc 150-150' between an inlet end 151-151' and an outlet end 152-152'. Substantially semicircular arc 150-150' reduces the flag dimension since by creating a continuous curve in flow tubes 103A-103B. Substantially semicircular arc 150 must be used in order to allow flow tubes 103A-103B to be of a sufficient diameter to facilitate large flow rates of material flowing through Coriolis flowmeter 5. In order to connect flow tubes 103A-103B serially into a pipeline, inlet manifold 102 and outlet manifold 102' may have a substantially 90 degree bend in a flow path to direct flow from the pipeline into substantially semicircular arc 150-150'.

To achieve zero stability and to separate vibrational modes of the flow tubes 103 A-103B, a first brace bar 120 and a second brace bar 121 are affixed to flow tubes 103A and 103B. First brace bar 120 is affixed to flow tubes 103A-103B proximate inlet end 151 to connect flow tubes 103A and 103B to control oscillations of flow tubes 103A-103B. Second brace bar 121 is affixed to flow tubes 103A-103B proximate outlet end 152 to connect flow tubes 103A and 103B to control oscillations of flow tubes 103A-103B. In a preferred exemplary embodiment, first brace bar 120 and second brace bar 121 are affixed to flow tubes 103A-103B substantially 180 degrees apart from each other on substantially semicircular arc 150.

Driver 104 is affixed to flow tube 103A and 103B at a position on semicircular arc 150 that is substantially at a midpoint between inlet 151 and outlet 152 of flow tubes 103A-103B. This position allows driver 104 to apply the greatest amount of force to flow tubes 103A-103B using the least amount of power. Driver 104 receives signals from meter electronics 20 via path 110 that cause driver 104 to oscillate at a desired amplitude and frequency. In a preferred exemplary embodiment, the frequency of a vibration is substantially equal to a first out of phase bending mode of flow tubes 103A-103B which is a higher frequency than conventional Coriolis flowmeters. In order to reduce stress from the higher frequency, it is desired to

maintain a low amplitude of vibration in the preferred exemplary embodiment.

In order to vibrate flow tubes 103A-103B at a high frequency and low amplitude. Pick-off sensors 105-105' must be affixed to flow tubes 103A-103B at position where the greatest amount of vibration may be sensed in flow tubes 103A-103B. This allows pick-off sensors 105-105' to detect the greatest amount of effect of Coriolis forces caused by the flowing material. In a preferred embodiment, the pick-off sensors are positioned at a position that is substantially 30 degrees from axises w-w'. However, the pick-off sensors may be placed at a position anywhere between 25 and 50 degrees from the w-w' axises when conventional electronics are used to drive the flowmeter.

A Spacer Affixed To Manifold 102 and 102'- FIG. 2.

FIG. 2 illustrates a spacer 200 affixed to flowmeter sensor 10. Space 200 maintains a constant distance between inlet manifold 102 and outlet manifold 102'. Unlike conventional spacers in Coriolis flowmeters, spacer 200 is made of minimal material. Spacer 200 has square ends 190-191 on opposing sides. In a preferred exemplary embodiment, the square ends 190-191 are cast as square plates in manifolds 102-102'. Four Walls represented by walls 201-202 connect each edge of square bases 190-191 to form an enclosure. Openings 210 allow substantially semicircular arcs 150-150' of flow tube 103A-103B to protrude from spacer 200.

A Casing for Flow Tubes 103A-103B- FIG. 3.

FIG. 3 illustrates a casing 300 for enclosing flow tube 103A-103B (Shown In FIG. 1). Casing 300 is a structure having a hollow inside that fits over flow tubes 103A-103B and is affixed to spacer 200 in some manner such as a weld, or nuts and bolts. Casing 300 prevents atmosphere from entering the enclosure.

Casing 300 may resonate at a frequency that is substantially equal to the frequency of the desired mode of vibration of flow tubes 103A-103B. If this is the case it is desirable to change the resonant frequency of casing 300 to prevent misreadings of the vibrations of flow tubes 103A-103B. One solution is to affix mass 301 to a substantially flat portion 302 of casing 300. One skilled in the art will recognize that the mass may be added as part of casing 300.

The above is a description of a Coriolis flowmeter having a minimal flag dimension. It is expected that those skilled in the art can and will design other

Coriolis flow meters that infringe on this invention as set forth in the claims below either literally or through the Doctrine of Equivalents.

WHAT IS CLAIMED IS:

1. A Coriolis flowmeter having a reduced flag dimension comprising:

a first flow tube;

a second flow tube;

a substantially semicircular arc between an inlet end and an outlet end of each of said first flow tube and second flow tube;

a driver affixed to said first and said second flow tube at a point on said substantially semicircular arc that is substantially perpendicular to bending axises of said first and said second flow tube wherein said driver oscillates said first flow tube and said second flow tube in opposition to each other;

a first brace bar affixed said first flow tube and said second flow tube proximate said inlet end;

a second brace bar affixed to said first flow tube and said second flow tube proximate said outlet end; and

pick-off sensors affixed to said first and said second flow tubes in a position that allows said pick-off sensors to detect the greatest amount of Coriolis force at a low amplitude vibration.

2. The Coriolis flowmeter of claim 1 further comprising:

an inlet manifold affixed to said inlet ends of said first flow tube and said second flow tube to affix said first flow tube and said second flow tube to a pipeline.

3. The Coriolis flowmeter of claim 2 further comprising:

a substantially 90 degree bend in a flow path through said inlet manifold.

4. The Coriolis flowmeter of claim 1 further comprising:

an outlet manifold affixed to outlet ends of said first flow tube and said second flow tube to connect said first flow tube and said second flow tube to a pipeline.

5. The Coriolis flowmeter of claim 4 further comprising:

a substantially 90 degree bend in a flow path though said outlet manifold.

6. The Coriolis flowmeter of claim 1 further comprising:

an inlet manifold affixed to said inlet ends of said first flow tube and said second flow tube to affix said first flow tube and said second flow tube to a pipeline;

an outlet manifold affixed to outlet ends of said first flow tube and said second flow tube to connect said first flow tube and said second flow tube to a pipeline; and

a spacer affixed to said inlet manifold and said outlet manifold to maintain a fixed distance between said inlet manifold and said outlet manifold.

7. The Coriolis flowmeter of claim 6 wherein said spacer comprises:

an inlet end affixed to said inlet manifold;

an outlet end affixed to said outlet manifold;

a top side, a bottom side, a front side, and a back side between said inlet and outlet ends; and

openings through said top side of said spacer through which said first flow tube and said second flow tube are affixed to said inlet and said outlet manifold.

8. The Coriolis flowmeter of claim 7 further comprising:

a casing that encloses said first flow tube and said second flow tube affixed to said top side of said spacer.

9. The Coriolis flowmeter of claim 8 wherein said casing comprises:

a front side wall;

a back side wall; and

a mass affixed to said front side wall and said back side wall to changes vibrational modes of said housing.

10. The Coriolis flowmeter of claim 1 wherein said position of said pick-off sensors is substantially 25-50 degrees from said bending axises of said first and said second flow tube.

11. The Coriolis flowmeter of claim 10 wherein said position of said pick-off sensors is 30 degrees from said bending axises of said first and said second flow

tube.

ABSTRACT

A Coriolis flowmeter sensor capable of handling large mass flow rates and having a reduced flag dimension. In order to have a reduced flag dimension, the flow tubes are formed to have a substantially semicircular arc between an inlet and an outlet. Brace bars connected to the flow tube proximate, the inlet and outlet, separate the frequencies of vibration in the flow tubes. Pick-off sensors are positioned upon the substantially semicircular arc of the flow tube at a position that allow the sensors to maximize detection of low amplitude, high frequency vibrations of the flow tubes required to have a reduced flag dimension.

FIG. 1

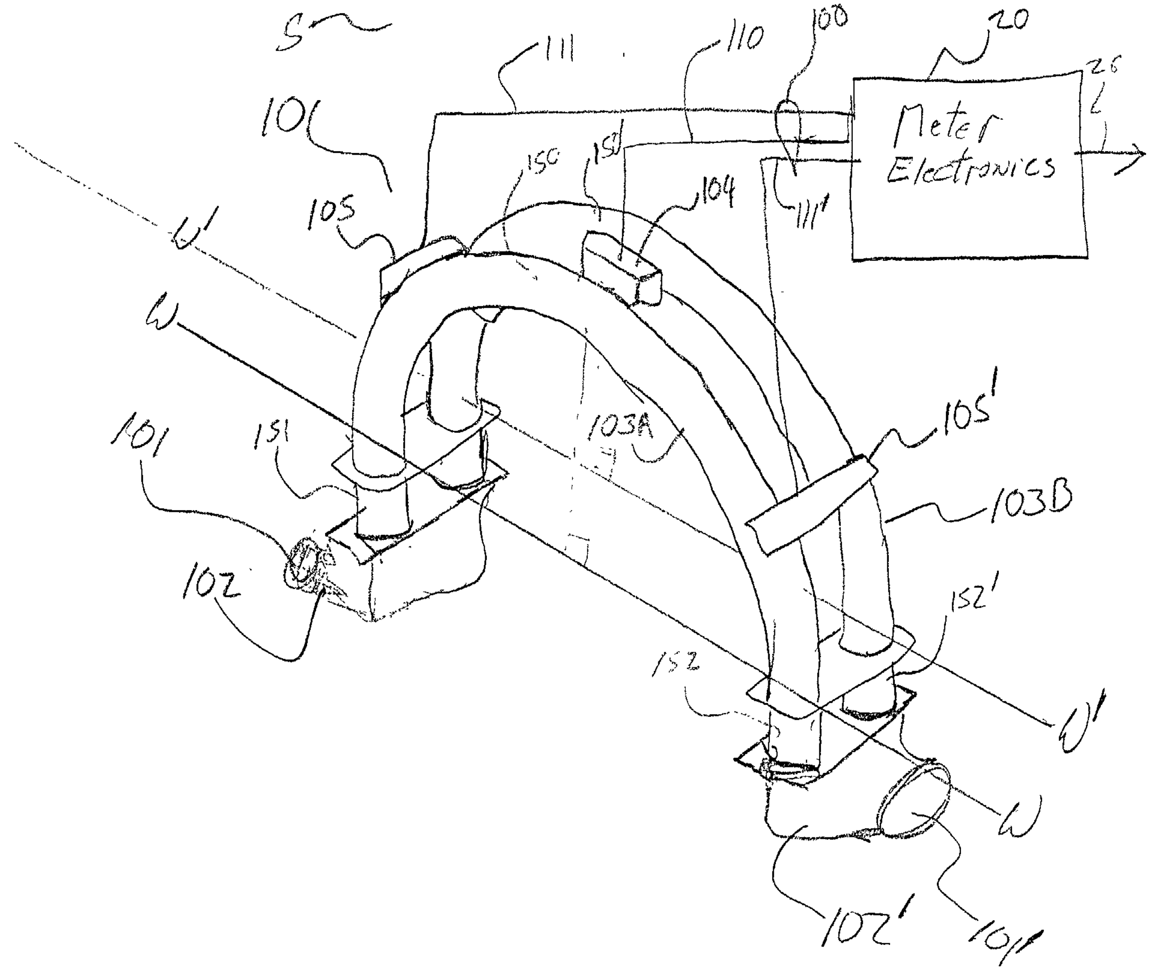

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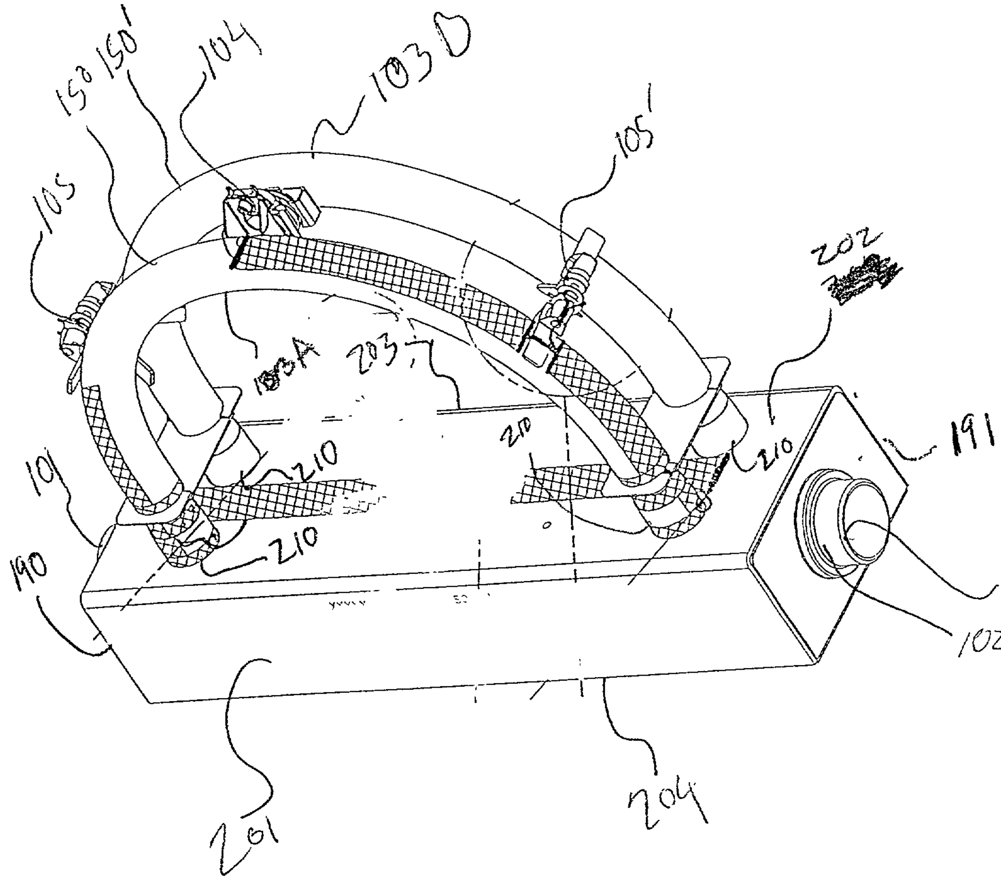
FIG. 2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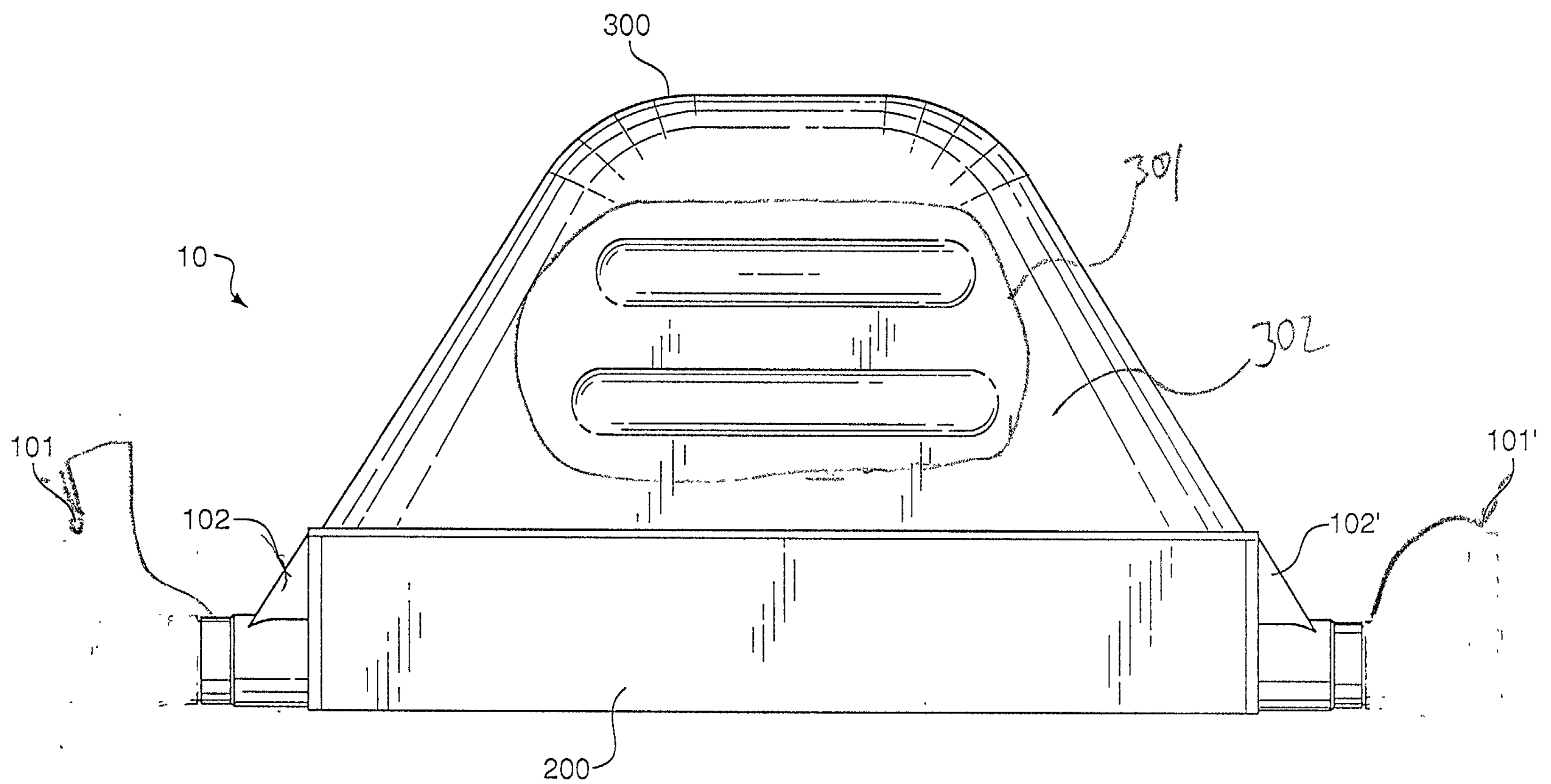

FIG. 3

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL, CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is for an original application.

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor *(if only one name is listed below)* or an original, first and joint inventor *(if plural names are listed below)* of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

A CORIOLIS FLOWMETER HAVING A REDUCED FLAG DIMENSION FOR HANDLING LARGE MASS FLOWS

SPECIFICATION IDENTIFICATION

The specification is attached hereto.

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56, and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent.

POWER OF ATTORNEY

I hereby appoint the following practitioners to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURES

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